

Author: Ida Lucy Iacobucci, 2015

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Chapter 7

EXODEVIATION

I. INTRODUCTION

A. Etiology

The same for Exophoria, Intermittent Exotropia, and Exotropia.

1. Anatomical
Divergent position of the orbits, divergent position of the rest or abnormal insertions of muscle and check ligaments.
2. Optical
Defective vision in one eye occurring after childhood or in very early infancy.
3. Accommodative
Secondary to weak or infrequently used accommodation
 - a. Accommodation not used with presbyopic correction.
 - b. Uncorrected astigmatism or uncorrected myopia (no accommodation needed for clear near vision).
 - c. Uncorrected high or moderate hyperopia with fatigue from accommodative effort or problem with hypoaccommodation.
4. Neurogenic
 - a. Paresis of an adductor.
 - b. Disturbance of central innervations controlling convergence and divergence.

B. Measurements

Measurements for all exo patients in primary position should be done at *infinity*, 6 meters, 1/3 meter. Up, down, right and left gazes only at 6 meters.

II. COMITANT MANIFEST EXODEVIATION

A. Exophoria and Intermittent Exotropia

1. Basic Exophoria and Intermittent Exotropia

The amount of deviation with fusion suspended and with eyes in the un-accommodated state. The amount of deviation is the same for both distances and near.

a. Characteristics

- ii. Onset relatively late, common especially in adults.
- iii. Asthenopia.
- iv. Exophoria is equal for distance and near.
- v. NPC remote or normal.
- vi. Convergence amplitudes low.
- vii. Divergence amplitudes normal but can be low.
- viii. Suppression present in varying degrees (tropic state).

b. Treatment

- i. Proper correction of refractive error – astigmatism and myopia fully corrected, check for hypoaccommodation in hyperopia and minimally correct presbyopia.
- ii. Teach diplopia at the distance the patient is tropic or in older children and adults teach physiological diplopia awareness while maintaining a fused image.

c. Method of Teaching Diplopia with Red Filter and Penlight.

- i. At the point when suppression occurs either at distance or near teach the patient diplopia awareness. Red filter is placed in front of dominant eye and patient fixates at a penlight, the examiner flashes his own hand in front of the unfiltered eye until diplopia is elicited. The patient is asked to hold the diplopia for 50 counts, if unsuccessful in office give this exercise for home training but diplopia should be held for 100 counts. This home practice is performed for a total of 10 minutes daily, five days a week. Patient is seen in two to three weeks.

- ii. Stabilize fusion.
Once stable diplopia is elicited, then red glass fusion practice is given from the bridge of the nose to 6 meters away. Begin where patient sees one fused (pink) image and advance and recess from that position. This practice is done in five minute sessions three times a day. Patient returns in three weeks.
- iii. Physiologic diplopia with anti-suppression practices for distance and near fixation.
 - a. *Framing* - is an excellent distance practice. Have patient fix at a distant object and place a pencil or finger in front of his eyes. He or she should be aware of 2 pencils or 2 fingers as he fuses the distant object. If the patient is having difficulty seeing 2 fingers or pencils, shake finger or pencil briskly until he or she appreciates physiological diplopia. The patient starts at near to obtain a single picture on the TV and recesses back to 6 meters.
 - b. *Bar reading* – is an excellent near practice. While reading at near, hold a pencil (or finger or bar) in front of the book and patient should see 2 bars (or 2 fingers or 2 pencils) while reading. If he loses part of the page, suppression is present. These practices are performed 15 minutes a day.
- iv. Increase relative fusional convergence amplitudes.
Once stable fusion is achieved with the above eye exercises, initiate loose base-out prisms taped to the spectacles and if no correction buy sunglasses and remove lenses. Begin with a 5^Δ base-out prism and gradually increase the prism strength to 20 prism diopters. Begin at the distance single clear image is achieved and maintain fusion to a distance of 6 m to 1/3 m.
- v. Fresnel press-on prisms management.
If symptoms persist after normal amplitudes have been accomplished, the patient is given base-in Fresnel press-on prisms for the amount of exodeviation present. This method is used mainly in older children

and adults. They are worn for 1-2 weeks as a trial period to evaluate improvement of symptoms. Should symptoms be relieved, slowly reduce strength of the prism. If unsuccessful in reducing the prism, permanent base-in prism in spectacles may be considered but are usually not recommended, since in most cases the amount of base-in prism needed for comfortable binocular vision increases with passage of time.

- vi. Surgery management is usually considered for the total amount of exodeviation.

2. Intermittent Exotropia - Divergence Excess Type

Deviation greater at distance and may be a constant. This type of deviation is greater at distance, may be phoric or intermittent for near. If tropic at distance and phoric for near, it is called periodic exotropia.

a. Measurements

Measure the patient in primary position at *infinity*, 6 meters and 1/3 meter, up-down, right-left gazes.

In divergence excess type additional measurements with +3.00 at near (1/2 hour) to check if deviation increases due to accommodative convergence or occlusion at near (1/2 hour) to determine if measurements increase due to fusional mechanism. This differentiates between simulated divergence excess and an actual divergence excess type.

b. Characteristics

- i. Gradual onset, usually early but may be later.
- ii. Usually closes one eye in sunlight.
- iii. X or XT greater at distance; less exodeviation or orthophoria for near. (Deviation at 200 feet greater than at 20 feet).
- iv. Deviation at distance may be X (I) or XT.
- v. NPC may be normal.
- vi. Convergence amplitudes normal for near, distance convergence poor to good with or without suppression at break-point.
- vii. Divergence amplitudes could be excessive to poor.

- viii. Amblyopia is rare; suppression more frequent at distance.
- ix. Possible overaction of the lateral rectus.

c. Treatment – Two methods of therapy

- i. Alternate occlusion or occlusion of the preferred eye if amblyopia is present. This method prevents reinforcement of suppression and enhances stable fusion. Patient wears the patch four to six hours a day, followed at two month intervals. If stable fusion is not achieved in six months the patient is a candidate for surgical management.
- ii. Increase relative fusional convergence with physiologic diplopia awareness if suppression is present.

A base-out prism is selected in the office. For example, if the patient can fuse a 5^Δ base-out prism at near but not at distance, the patient is sent home with a loose 5^Δ base-out prism which he will tape on his glasses. If no prescription, have the patient buy a cheap pair of sunglasses and pop out the lens. Patient will start close to the TV or picture until a *clear single image* is seen, slowly move back from TV until image blurred or doubled and again move toward the TV, once a *clear single picture* is regained start again and the objective is 6 meters. This recession practice is performed 20 minutes a day, patient is seen at four to six week intervals to monitor improvement and increase strength of prism. Surgical management is considered if a stable alignment is not achieved in six months.

- iii. Surgical management can be considered without occlusion therapy or fusional amplitude training. It depends upon the amount and frequency of exodeviation and refixation with the alternate cover test.
- iv. Postop Treatment

NOTE: It is important to measure in right and left fields for any incomitance.

If overcorrection is 5-20^Δ E (T) – ET for either distance or near or both distance and near, give no treatment but check patient at weekly or two week intervals. Deviation should gradually become less in amount and constancy at each visit. Should it stay the same or esotropia increases – initiate full time alternate occlusion to stop the over-convergence response.

The over-convergence response is due to the fact that when the patient was previously exotropic, they learned to converge to eliminate diplopia and continued to over-converge to eliminate diplopia in the new, esotropic position. The patient should be seen at one week intervals since the esotropia may be quickly resolved once the stimulus to over-convergence is eliminated.

- a. Check if hyperopia is present – even one diopter of hyperopic correction plays a significant part in eliminating the esodeviation.
- b. If the hyperopic correction was given and the ET was resolved, follow and treat as an accommodative esotropia.
- c. If a hyperopic correction has no effect, give Fresnel base-out prisms in the amount to slightly overcorrect the esodeviation. The patients should be seen at two week intervals to attempt gradual reduction of prism. The method is as follows:

5^Δ BI clip-on prism is worn for 20 minutes in the office. If fusion is still maintained, a 3 to 5^Δ reduction in prism is prescribed. If reduction of prism is unsuccessful following a two month period – surgical intervention is indicated.

- v. Marked Overcorrection – 25-45^Δ ET - Consider blind spot syndrome
 - a. Usually glasses have no effect consider full time alternate occlusion to stop the over convergence impulse. Check at two week intervals if the esotropia continues to decrease.

- b. If no improvement for two weeks give base-out press-on prism in the amount to slightly overcorrect the esotropia. In a fusion or no fusion response, surgery is performed for the total amount of esodeviation.

vi. Under-correction – Minimal Residual Exophoria

IMPORTANT: Remember to re-measure in all fields to observe any incomitance. No treatment indicated, but observe the patient at 3 to 4 month intervals.

vii. Marked under-correction – Residual X(T) or XT

If moderate to large exodeviation is present postop minus lenses may be considered in children as a temporizing method. However in this situation of marked under-correction, press-on prisms play significant roles to prognosticate the patient's sensory and motor response for additional surgery.

3. Convergence Insufficiency (X - X(T) – XT) – Deviation greater for near

a. Etiology: anatomic, optical, accommodative, or Neurogenic

- i. General disease or debility; e.g. toxic conditions.
- ii. Psychopathic instability.
- iii. Secondary to divergence excess.

b. Characteristics

- i. Late onset.
- ii. Asthenopia associated with near work.
- iii. X or XT greater for near, less X or ortho for distance.
- iv. Remote NPC, more remote when tested with red filter.
- v. Prism divergence normal.
- vi. Prism convergence low for distance and near.
- vii. Amblyopia rare.
- viii. NRC is usually present.
- ix. Suppression more frequent for near.
- x. Accommodation may be weak or the patient may demonstrate a low AC/A ratio or fall in the hypoaccommodative group.

- c. Treatment
 - i. Red filter with penlight progression to bridge of nose or NPC with an accommodative target.
 - ii. Initiate base-out practice in the following situations.
 - a. Red Glass progressive practice to bridge of nose.
 - b. Reading or various near projects in young children.
 - c. If suppression is present teach the child or adult physiologic diplopia awareness. Could use pencil or finger.

In both situations begin with 5^Δ base-out loose prism and gradually increase to 20^Δ base-out prism (total of 20 minutes per day at five minute intervals).

- iii. If symptoms are not relieved, surgery is decided on the total amount of near deviation and in some cases, press-on prisms may be considered preoperatively to determine postop response.

4. Convergence Insufficiency and Hypoaccommodation.

In cases where accommodation is not used [as in presbyopia, uncorrected myopia (requires no accommodation for close vision), uncorrected moderate to high hyperopia who suffers fatigue from accommodative effort], XT may develop for near. Treatment is the same as for convergence insufficiency. Care must be paid to proper correction of refractive error and this alone may be sufficient treatment in many cases. Wear correction for one month and do simple NPC exercises with a red filter and a light. If symptoms still present, attempt a trial with base-in Fresnel bifocal in the amount to neutralize deviation to check if symptoms are relieved. Once symptoms are relieved, increase relative fusional convergence and slowly reduce the base-in Fresnels. If a reduction is unsuccessful, surgery is considered as described in the above convergence insufficiency group.

B. Constant Exotropia

1. Exotropia-Basic, Divergence Excess, Convergence Insufficiency Type.

Probably most strabismic patients in this category were originally intermittent in character and, with time, become constant. They may follow the pattern of any of the previously discussed groups or a combination of them.

a. Treatment

- i. Proper correction of refractive error and eliminate amblyopia in children.
- ii. Measure in primary position at infinity, 6 meters, 1/3 meters, also in right-left, up-down, gazes at distance.
- iii. With neutralized prism in the office evaluate the response with the red glass and Worth 4-dot test at distance and near. Also check stereopsis.
- iv. Management and surgery depends upon type of exodeviation as discussed in the previous sections.
- v. Postop treatment (under-corrected)
 - (a) Phoric or intermittent (under 10 to 15^Δ), increase and stabilize relative fusional convergence with loose base-out prisms. Press-on prism reduction is usually unsuccessful.
 - (b) If residual exodeviation is 20^Δ or greater, prescribe a base-in press-on prism for 1 to 2 weeks to assess sensory and motor response. In the presence of no fusion, the patient may be acceptable cosmetically and additional surgical management may not be indicated. In a fusion response, attempt gradual reduction of base-in press-on prisms. However, if reduction is unsuccessful, additional surgery may be considered.
 - (c) If residual 25^Δ XT or more, additional surgery is indicated. Before doing next procedure, initiate press-on prisms to determine postoperative response.
 - (d) Minus lenses may be considered as a temporary management.

- vi. Post-op Treatment (overcorrected group)
 - (a) Initiate full-time alternate patch to stop over convergence response. Check patient at two week intervals and continue alternate occlusion until esodeviation is resolved. Discontinue occlusion if no change in esodeviation for 2 consecutive weeks and initiate press-on prism management.
 - (b) Refer to section on press-on prism management in basic, divergence excess and convergence insufficiency group.

2. Sensory XT

Early infancy or after adolescence, the vision of an eye becomes grossly defective due to congenital deformity or a result of an injury. It is very probable that the affected eye will become divergent.

- a. Characteristics
 - i. Onset at any time.
 - ii. Unilateral strabismus.
 - iii. Stable angle of deviation at distance and near.
- b. Treatment
 - i. Occlusion Therapy – patch the dominant eye to improve VA in the defective amblyopic eye. Check types of occlusion in amblyopia lecture.
 - ii. Once optimum VA is achieved in the defective vision eye, attempt to facilitate central or peripheral fusion with Fresnel press-on prisms. Press-on prism is placed in front of preferred eye (if not tolerated) transfer to the defective visual acuity eye. Treat as discussed in Press-On Prism lecture.
 - iii. If fusion is present with POP, surgery can be considered with the assurance of obtaining fusion postoperatively. If no fusion response or diplopia surgery is performed for cosmesis only.

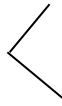
3. Consecutive XT (Also referred as secondary XT)
 - a. Characteristics
 - i. An accommodative ET, especially with a high AC/A ratio, may become XT due to his hyperopic correction.
 - ii. An ET patient over responds to surgery and becomes an XT. A consecutive XT may develop immediately postoperatively or several weeks or months later. An over response following bimedial recessions usually shows a divergence excess type XT. An over response following a recess-resect procedure usually shows a convergence insufficiency type of deviation.
 - b. Treatment
 - i. Overcorrected hyperope-consecutive XT. Treatment is refractive and reduction of plus sphere correction until the patient is esophoric or under 10 prism diopters of exodeviation. Testing for the amount of cut is done with minus clip-on spheres and muscle measurements in the office. However, high hyperopes will need enough correction for good vision and, if still exotropic, a trial of base-in press-on prisms can be attempted to facilitate fusion. If *fusion present*, attempt to increase convergence amplitudes and slowly reduce the prism. If prisms cannot be reduced, surgery is performed for total amount of prisms prescribed. If no fusion present and cosmetically acceptable, further treatment is not indicated.
 - ii. In *intermittent* or constant exotropia patients who have undergone two or more unsuccessful XT surgeries, *minus lens therapy* is an excellent temporizing modality to reduce the exodeviation. It provides cosmesis in exotropia (with no fusion) and comfortable SBV in X(I) fusion patients. To determine the strength of minus lenses, the patient attends a 20/30 target at six meters. The strength of minus lenses is increased at 1 diopter increments until a 20/30 target at six meters becomes blurred.

III. INCOMITANT MANIFEST EXODEVIATION

A. Third Cranial Nerve Palsy (Ocular Motor Nerve) - Anatomy

1. Anatomy - Primary Ocular Motor Nerve of the Eye

Originates - In front of cerebral aqueduct.

- Midbrain areas of brainstem
- Runs through the cavernous sinus
- Enters through superior orbital fissure
- Divides 
 - Superior division innervates SR and eyelid levator muscle
 - Inferior division innervates the MR, IR, IO muscle
- Carries parasympathetic fibers to pupil sphincter and ciliary body muscles

Parasympathetic Nervous System

1. Part of the autonomic nervous system
2. Nerve fibers to the eye travel within the 3rd nerve and provide innervation to ciliary body for accommodation, aqueous production and sphincter to decrease pupil size (miosis).
3. Controlled by acetylcholine-chemical allows nerve transmission used by cholinesterase.

B. Characteristics and Pathologic condition

1. Sudden onset, accident, vascular or viral.
2. Onset accompanied by severe pain on ipsilateral forehead and face.
3. CT angiogram must be ordered right away to rule out aneurysm of posterior communicating artery.
2. Eye is down and out.
3. Weakness of muscles innervated by 3rd nerve.

4. Includes the eyelid levator, IO, MR, IR, SR and sometimes pupillary sphincter and ciliary muscles.
5. Involved eye deviates outward, slightly downward and droopy (ptotic) eyelid without lid fold.
6. Pupil may be dilated accommodation reduced.
7. Postures to fuse.

C. Treatment

Surgery

IV. MEDIAL RECTUS PARALYSIS (RARE)

A. Etiology

A partial third nerve palsy only involving the medial rectus is rare. It should be differentiated from internuclear ophthalmoplegia with an etiology of a lesion in the medial longitudinal fasciculus. With internuclear ophthalmoplegia adduction is nil unilaterally or bilaterally with asymmetric nystagmus in abduction. Myasthenia gravis also needs to be ruled out before diagnosis of medial rectus palsy is made.

B. Characteristics

1. Limitation of adduction.
2. Eyes usually abducted, but may be parallel in primary position due to convergence and active accommodative-convergence innervation.
3. Frequently associated with dysfunction of the oblique muscles.

C. Treatment

Surgery